PROJECT REPORT

Incorporating Photo-Book of Concepts in Physics and Environmental Chemistry Courses

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Abstract

Much has been written about the importance of helping students gain critical thinking and analytical reasoning skills that are transferable beyond classroom situations (Association of American Colleges and Universities 2007; Kuh 2008). Student engagement correlates positively to these skills as well (Carini et al. 2006). To this end, the photo-book activity was designed to allow students opportunities to connect real-world applications with course concepts. By analyzing the relationship of the subject matter to the real world, students reinforce their understanding and application of ideas learned in class. In the photo-book project, students were asked to capture class concepts in pictures. This assignment encouraged students to be more observant and to search for examples in their world and further allowed them to freely express their interpretation of the subject and reflect on their learning. This project was embedded in various classes (as recommended by Pithers and Soden 2000) such as physics, environmental chemistry, and climate change, and also in community projects such as Earth Week. In this paper we discuss the details of the photo-book concept, offer examples of students' comments, and finally, present an overview of this learning model.

Introduction

Critical thinking and analytical reasoning, problem-solving skills, and the ability to understand varying perspectives on issues are among the traits valued by employers in evaluating job applicants. As knowledge is expanding so quickly, students cannot possibly master content knowledge; the key is to learn habits of mind that will enable them to continue learning beyond their formal academic training. Experiential learning activities can help students integrate and apply skills and knowledge in real-world settings and situations, and thus accelerate their success (Association of American Colleges and Universities 2007; Kuh 2008; Texas Woman's University 2013). Furthermore, student engagement is positively linked to learning outcomes such as critical thinking and grades (Carini et al. 2006). Extensive research also suggests that students need to "think well," and activities should be embedded in courses to encourage critical thinking (Pithers and Soden 2000 and references therein).

Texas Woman's University (TWU) founders recognized the importance of this and adopted the University motto, "We learn to do by doing." Stemming from a quote by Comenius (considered the father of modern education) and recommended by Helen Stoddard, one of TWU's first Regents, the motto captures the unique

focus of a TWU education so well that it was engraved on the University's first building (Bridges 2001, 7).

At TWU, experiential learning may include internships, service learning projects, civic engagement, scholarship, or creative activities. Creative activities include projects that provide students with real-life, hands-on experiences. Engaging students in creative activity reinforces academic knowledge and establishes a foundation for academic growth. Student experiences may extend beyond the classroom. The photo-book project described in this paper is one such creative activity. Universities are increasingly incorporating such opportunities into the curriculum and institutional offerings (Karukstis 2010; Lopatto 2010; Malachowski and Dwyer 2011; Sheardy 2010; Sloane 2010). Thiry et al. (2011) note, "Undergraduate science education should be augmented by student engagement in high quality, 'real world' experiences that meet students' broad range of interests, talents, and career goals. Well-designed experiences supplement classroom learning in many ways…" (384). Asking students to contextualize what they are learning in class should be expected to inspire motivation (Fisher 2016). Understanding how our students are motivated and finding practical strategies can improve the quality of learning in our courses (Ambrose et al. 2010). Eyler (2009) suggests the benefits include "a deeper understanding of subject matter than is possible through classroom study alone; the capacity for critical thinking and application of knowledge in complex or ambiguous situations" (26). Such activities provide a means to both enhance student engagement and to better prepare students for success after graduation.

TWU's Quality Enhancement Plan (QEP), *Pioneering Pathways: Learn by Doing*, is a five-year plan mandated by our accrediting agency. It is designed to enhance student learning through student engagement in experiential learning.

The intention of this project is expressed in the words of Benjamin Franklin, "Tell me and I forget, Teach me and I remember, Involve me and I will learn." Learning by doing and applying theory to practice is considered crucial for student success in an ever-changing, increasingly connected, and global world. The related QEP Student Learning Outcome (SLO) for our photo-book activity is for students to *effectively connect classroom theories to real-world experiences through practical application of knowledge*. In this paper we discuss three QEP-designated courses and how this SLO was addressed using the photo-book of concepts in each course.

Beginning in the summer of 2007, faculty at TWU engaged with the SENCER community of practitioners to improve science education. SENCER focuses on real-world problems and, by so doing, extends the impact of this learning across the curriculum to the broader community and society. Faculty develop expertise in teaching "to" basic, canonical science and mathematics "through" complex, capacious, often unsolved problems of civic consequence. Using materials, assessment instruments, and research developed through SENCER, faculty members design curricular projects that connect science learning to real-world challenges (Middlecamp 2011; Sheardy 2010; Sheardy and Burns 2012). The SENCER understanding of learning acknowledges a debt to the philosopher William James, who wrote in his *Talks to Teachers* (1899):

> *Any object not interesting in itself may become interesting through becoming associated with an object in which an interest already exists. The two associated objects grow, as it were, together: the interesting portion sheds its quality over the whole; and thus things not interesting in their own right borrow an interest which becomes as real and as strong as that of any natively interesting thing. The odd circumstance is that the borrowing does not impoverish the source, the objects taken together being more interesting, perhaps, than the originally interesting portion was by itself.*

More contemporaneously, SENCER's work is informed by the National Academies' commissioned reports on learning, notably *How People Learn and Knowing What Students Know: The Science and Design of Educational Assessment* (Bransford et al. 2000; Pellegrino et al. 2001). SENCER Ideals have been applied to develop field-tested courses for many disciplines on a broad range of topics. Among those ideals, "SENCER conceives the intellectual project as practical and engaged from the start, as opposed to science education models that view the mind as a kind of storage shed where abstract knowledge may be secreted for vague potential uses." Students and faculty report that the SENCER approach makes science more real, accessible, useful, and civically important (Carroll 2012).

We are introducing a creative activity we call photo-book of concepts included in three courses (physics, environmental chemistry, and climate change) at TWU. Each is a QEP-designated course at TWU; each is also a SENCER course. Maguire's environmental chemistry course was, in fact, our first SENCERized course.

Photo-Book of Concepts

The photo-book project described here is an example of a learning activity which also includes the guided reflection concept. We teach students the laws and concepts of the subject matter in the classroom. Then students have a chance to independently think about what they have learned in the class and look around for illustrations of the concepts in their everyday lives. This activity encourages students to be more observant and search for examples in their world. This assignment allows them to freely express their interpretation of the subject and reflect on their learning. In this project students are required to take a few photographs (four to six) that represent the ideas in the subject matter. Students need to email two of their pictures to the instructor, each on a single slide in a presentation file format, along with a title and a description of what concept each picture represents. (See Figures 2, 5 and 6 for examples.) The instructor gives feedback to help students focus on successful ways of thinking about the assignment. After receiving the comments back from the instructor, final pictures in the same format are sent to the instructor along with their titles and descriptions. The instructor then chooses one picture from each student to exhibit on the wall of the classroom. At the exhibition, each student selects one picture (not their own) they find interesting and writes a reflective paragraph on why the photo grabbed their attention and how it relates to the subject matter. Finally, for a larger class the instructor chooses 15-20 representative pictures (the number is up to the instructor) that show different concepts in the course for printing on a poster. This poster could be displayed in the department and might even be presented in a larger scale on the campus or at conferences. For a smaller class, the instructor could divide students into groups and ask each group to make a poster presentation. More detailed instructions, examples of timelines, and detailed rubrics are included as an appendix to this article.

Physics

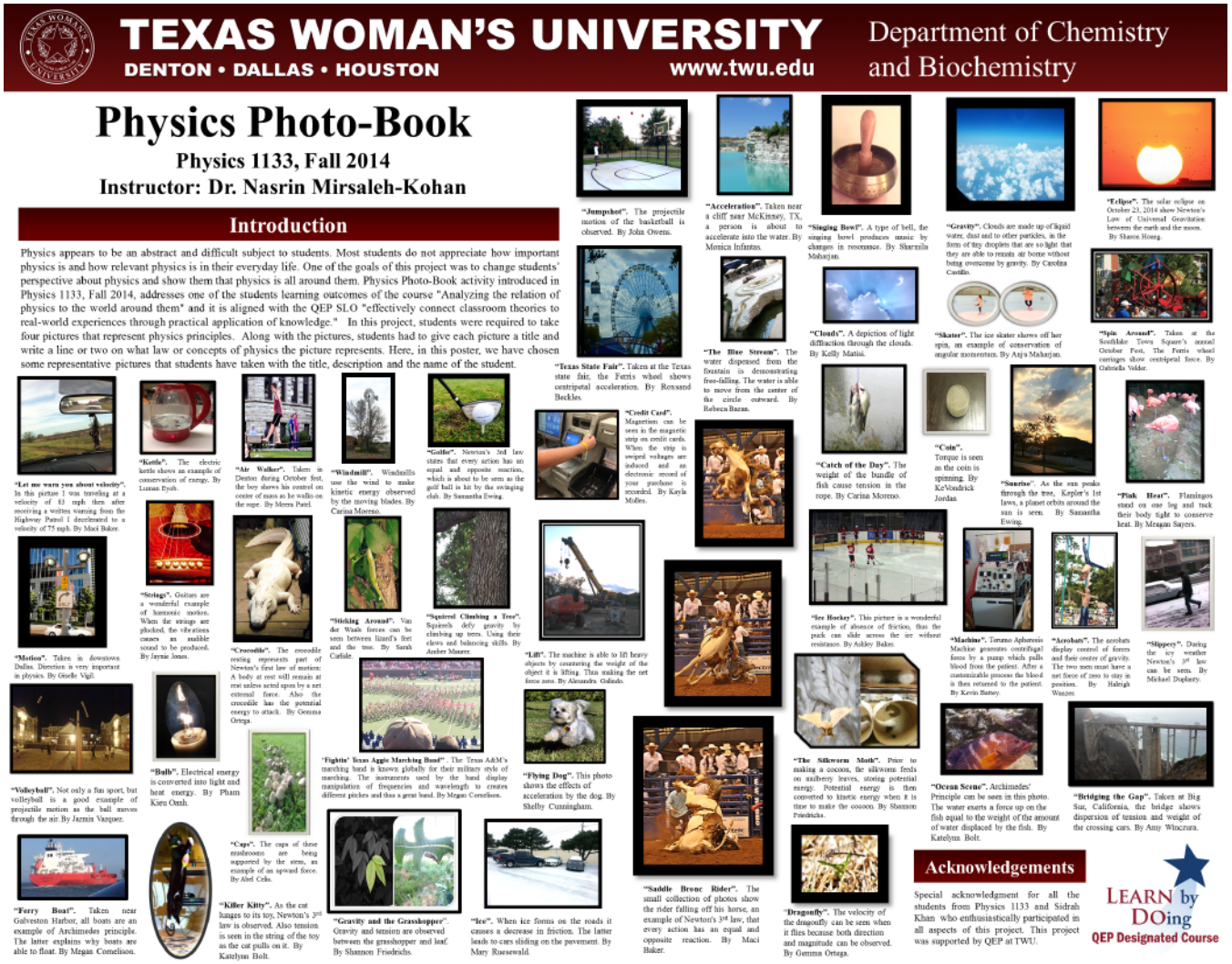
Physics appears to be an abstract and difficult subject to most students, especially if their major is not physics. Most students do not appreciate how important physics is and how relevant it is in their daily lives. The photo-book activity is a unique bridge between explaining physics concepts in a classroom and observing them in the real world. This activity was included for the first time in the algebra-based physics course in fall 2014, addressing one of the course SLOs, *analyzing the relation of physics to the world around them*. This activity was also aligned with the QEP SLO, *effectively connecting classroom theories to real-world experiences through practical application of knowledge*. There were seventy-five students enrolled in this class. As part of the class, students were assigned to start looking more carefully around them in search of physics and to capture physics principles in pictures or photographs. The idea behind this project was to change students' perspectives about physics. This activity required students to take four photographs (just to have a manageable number of pictures due to the large number of students) that represented physics principles. Pictures had to be photographs students captured personally (pictures taken online or from other sources were NOT accepted). For instance, they could take a picture of ice on a plant's leaves. This picture can represent the heat concept in physics and how water needs to be 0° Celsius to become ice. This assignment made them look at their world carefully, reflect on what they learned in the class and find physics. As they started to develop an awareness of physics more and more, the instructor hoped they would want to learn more. Students had to email two of their pictures in a presentation file to the instructor to receive preliminary feedback on their pictures. A few weeks later, they submitted all four pictures. The instructor chose one picture of the four from each student to exhibit on the wall of the physics laboratory so that all the students could see their classmates' work. At the exhibition, each student selected a photo that she thought perfectly showed physics and wrote a reflective paragraph about it. Since the students were asked to focus on just one picture, they were able to think about one physics concept more deeply and reflect their understanding in a written format. It was very interesting to read different students' reflections about the same picture, and see how each student emphasized

something completely different. For example, when we see a picture of an ice skater, we might see the concept of motion and Newton's second law in the picture. However, there is also conservation of angular momentum in the motion of an ice skater. When ice skaters close their arms, they will spin faster. Furthermore, reflective writings also revealed students' misunderstanding about a concept. Overall, displaying the pictures on the wall gave students an opportunity to share their experiences. Finally, we chose about forty-five most representative pictures showing different areas such as nature, chemistry, biology, and music and made a poster. This poster (shown in Figure 1) is displayed on the wall outside of the physics lab and was also presented at several university events (e.g. in the experiential learning showcase and at the Celebration of Science symposium at TWU). This poster was also presented at the 2015 SENCER Summer Institute in Worcester, MA. Moreover, presenting this poster to other students who were not taking physics sparked an interest in them and showed them physics in new places. This activity was also incorporated in the algebra-based physics course for fall 2015 and we will continue to include this project annually in physics classes.

Environmental Chemistry

TWU students enrolled in environmental chemistry during the spring 2014 semester were assigned to collect a series of eight photographs related to water issues, and the class will select the best for inclusion in posters to

FIGURE 1. An example of one of the posters made in the physics course.



be displayed during Earth Week (April 21–25). Figure 2 shows an example slide illustrating the assignment, which was submitted as a presentation file with one photo per slide. Students were encouraged to take their own photos, but were also allowed to use photos found online in cases where they needed material that is not available locally in north Texas (e.g. ocean garbage patch, etc.). Several opportunities for photography were offered during field trips to various places in and around our community. After all the photos were collected, they were printed on copy paper and displayed on a large wall during one class period. Students then worked in small groups of two or three to collect the best examples related to their particular water issue.

FIGURE 2. An example slide illustrating the assignment, which was submitted as a PowerPoint file with one photo per slide.

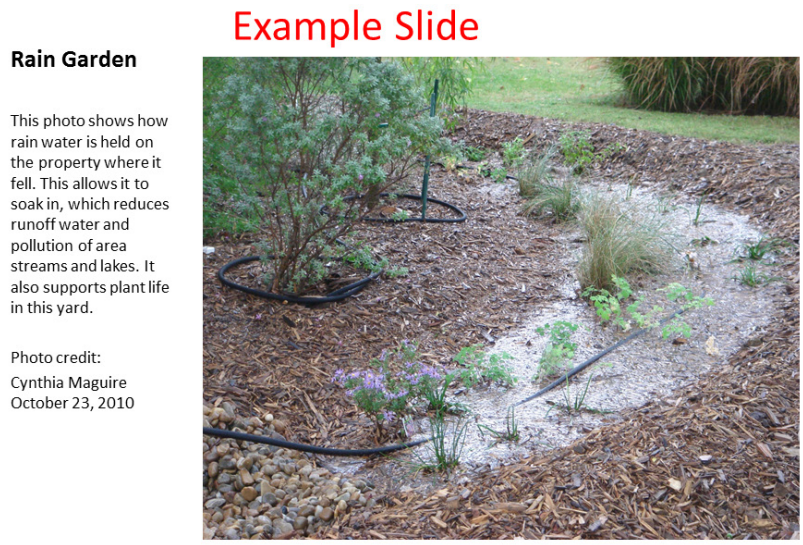
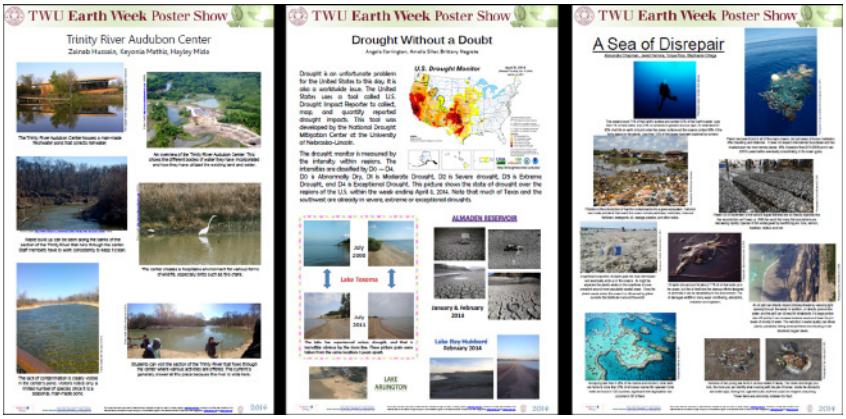


FIGURE 3. Selected water photo posters exhibited during the Earth Week poster show.



Earth Week Poster Show

Once each group had selected appropriate photos, environmental chemistry students were instructed to tell their water photo story in pictures with minimal words as captions for the photos. Their assignment included making the information understandable for elementary school children who would be attending the reception held during the Earth Week exhibition. A grading rubric (see appendix) was devised for this assignment prioritizing content, organization, and grammar. Selected water photo posters are shown in Figure 3.

Children in some area elementary schools were also invited to create posters and the best were chosen by a group of their faculty to be included in the TWU Earth Week exhibition. One of the instructor's goals in organizing this QEP- and SENCER-sponsored event was to increase the desire to attend college among school children participating, and to enhance their perception of TWU as a prospective institution to attend. The students and their families and teachers were all invited to the reception held on campus during the exhibition. The reception provided a time to share between the younger students and TWU environmental chemistry students. Selected children's posters are shown in Figure 4. In addition, organizing the exhibition provided an experiential learning opportunity for two elementary education majors taking the environmental chemistry course.

Climate Change

The Climate Change class in spring 2016 was assigned to take their own photos of climate change in the world around them. Their instructions were, "Photographs must be your own original work. They cannot show people's

faces and cannot include children. Each photograph must be in a common image format such as JPG or TIFF, and at least 1.0 MB file size in order to have adequate resolution if printed." Images were uploaded into the course Blackboard along with a descriptive paragraph to explain the image connection to climate change, as a portion of the credit for the midterm exams. The instructor (Maguire) failed to require use of a presentation file format for submissions, which led to increased difficulty correlating descriptions with photos.

FIGURE 4. Selected children's posters created by children in area elementary schools and exhibited at TWU's Earth Week poster show.

Consistent with the creativity shown in the physics and environmental chemistry courses, students in Climate Change were able to see impacts of changing climatic conditions in ordinary things around them. Photos included large hailstones from an unexpected and dramatic hail event in Fort Worth, a tree entangled in power lines, and an adult butterfly photographed in early January—unusual even for north Texas. A selection of photos and reflective writing descriptions are shown in Figure 5. Students were able to articulate that excessive precipitation, hailstorms, drought, technology impacts, and biological cycles outside of their usual timing were all perceivable manifestations of climate change. Maguire plans to create a climate change photo poster to promote the course on campus and to use when presenting the photo-book idea.

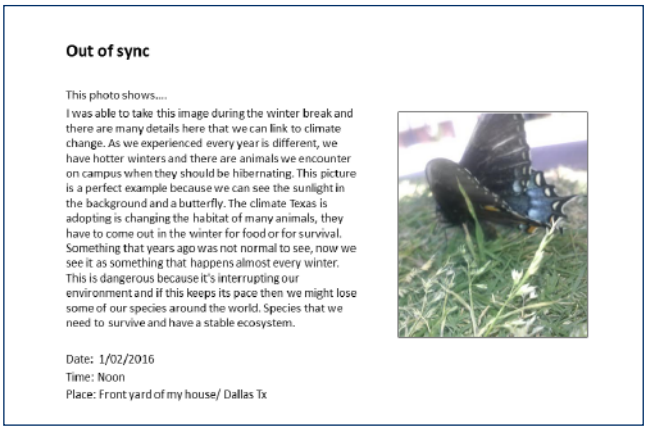
Assessment

We have employed direct and indirect assessments to measure students' learning in this project. In the direct assessment, we used students' photos to evaluate their understanding of the concepts presented in the pictures. The student learning objective for our QEP-designated courses was to *effectively connect classroom theories to real-world experiences through practical application of knowledge*. The photo-book assignment was used to measure this objective in all courses mentioned in this article. Grades on the photo-book of concepts tend to be higher than other coursework, indicating that students are able to connect classroom theories to real-world experiences, and that this activity was an effective tool in helping students achieve that connection. We have attempted to compare overall course averages using this assignment with classes that did not utilize the photo-book. Unfortunately, it is not possible to make a direct comparison because one of us was not teaching at TWU prior to using this assignment and the other made more than one change in her course design. No assessment data are available for the climate change course as it was still in progress when this article was written.

Indirect assessment of students' learning took place during the in-class picture exposition while students were sharing their ideas about other students' photos and also in a reflective writing piece that they submitted later. (See an example in Figure 6.) Moreover, students' comments in the course evaluations have demonstrated that this is an engaging activity for the students and further expands their understanding and appreciation of the subject matter. Unexpectedly, this project also leads students to learn more about their peers outside of class. Some students are passionate about rodeos, have traveled to exotic places, or have unique hobbies. In this experiential learning activity, students were more observant and searched for examples of the subject matter in their world. This assignment also allowed them to freely express their interpretation of the subject and reflect on their learning.

From course evaluation comments it is clear this activity was one of the students' favorites. They were also surprised how much they had "learned by doing." Here are a few of our students' comments as written in the physics class evaluation forms:

FIGURE 5A-C. A selection of photos and reflective writing descriptions submitted by students in the climate change course.



Out of sync

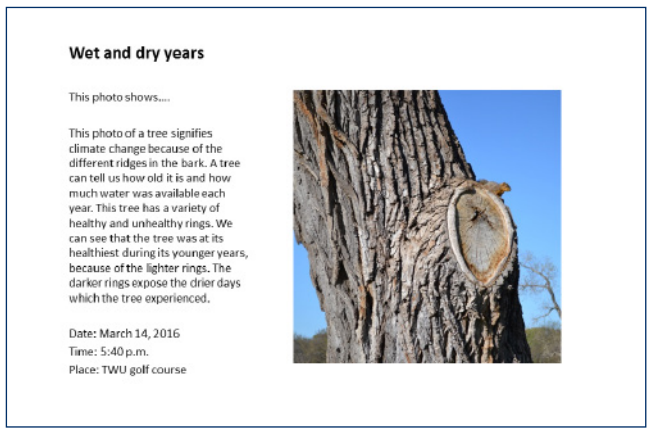
This photo shows....
I was able to take this image during the winter break and there are many details here that we can link to climate change. As we experienced every year is different, we have hotter winters and there are animals we encounter on campus when they should be hibernating. This picture is a perfect example because we can see the sunlight in the background and a butterfly. The climate Texas is adopting is changing the habitat of many animals, they have to come out in the winter for food or for survival. Something that years ago was not normal to see, now we see it as something that happens almost every winter. This is dangerous because it's interrupting our environment and if this keeps its pace then we might lose some of our species around the world. Species that we need to survive and have a stable ecosystem.

Date: 1/02/2016
Time: Noon
Place: Front yard of my house/ Dallas Tx

Trees vs. Technology

This photo shows....
There are many things going on around us that may seem important, the new iPhone, or new technology getting built. But we don't stop and think of the things that really matter around us, those things are changing and they are changing our environment. In the image above I was able to stop for a couple of minutes and contemplate about how technology is taking over our environment and more important how it's changing our climate. The image shows an electric pole head to head with a tree, but we can easily see that they are fighting for a "spot." The [branch] of the tree is trying to enforce its leaves over the cables but it is impossible for the environment to win on this one. It is impossible for the environment to be stable in a place where new technology is the most important thing. There is a collapse between the tree and the wires and we all know who is going to stay in the spot. It will be difficult for many to understand that climate change is affecting the trees like this one.

Date 03/12/2016
Time: 4 pm
Place: Street in Dallas TX



Wet and dry years

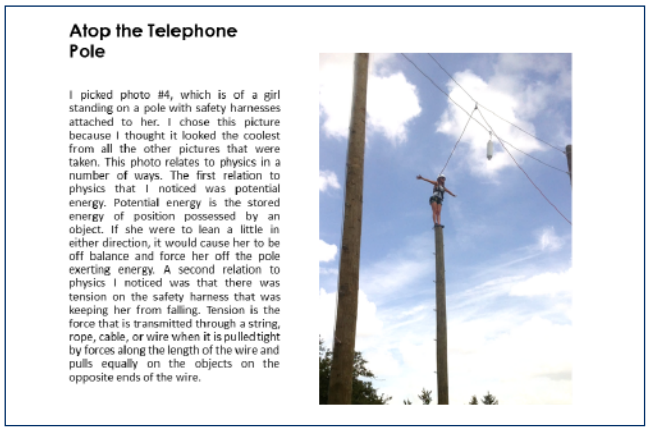
This photo shows....

This photo of a tree signifies climate change because of the different ridges in the bark. A tree can tell us how old it is and how much water was available each year. This tree has a variety of healthy and unhealthy rings. We can see that the tree was at its healthiest during its younger years, because of the lighter rings. The darker rings expose the drier days which the tree experienced.

Date: March 14, 2016
Time: 5:40 p.m.
Place: TWU golf course

- "The photo-book project, it was actually pretty interesting paying attention to a world filled with physics."
- "This course forces you to apply the concepts that you learn to things in your everyday life."
- "The teacher really shows that she cares and wants to work with us. I am very glad the homework allows multiple attempts because it helps me get through the thinking [process] no matter how long it takes. I enjoyed the Photo Book project."
- "The photo-book project was exciting and a fun way to learn the practical application of physics."
- "Being shown how we could really apply what was being taught in real life situations."
- From their comments, it is clear that the photo-book assignment led students to "think well" and critically, as Pithers and Soden (2000) predicted.

FIGURE 6. An example of a reflective writing piece; one student wrote this paragraph about another student's photo. The student who took the photo saw equilibrium. This student saw potential energy in this picture. Both concepts apply to this scene.



Atop the Telephone Pole

I picked photo #4, which is of a girl standing on a pole with safety harnesses attached to her. I chose this picture because I thought it looked the coolest from all the other pictures that were taken. This photo relates to physics in a number of ways. The first relation to physics that I noticed was potential energy. Potential energy is the stored energy of position possessed by an object. If she were to lean a little in either direction, it would cause her to be off balance and force her off the pole exerting energy. A second relation to physics I noticed was that there was tension on the safety harness that was keeping her from falling. Tension is the force that is transmitted through a string, rope, cable, or wire when it is pulled tight by forces along the length of the wire and pulls equally on the objects on the opposite ends of the wire.

One of the authors (Maguire) noticed when she included this project for Earth Week in her class she received one of the highest-ever course evaluation ratings from the students in that class; she has taught the course every semester since fall 2007. This higher rating might possibly be attributed to student motivation being higher since this project was a practical strategy to connect class concepts to students' interests (Ambrose et al. 2010); also, the students discovered how relevant these ideas are to the world around them, a key part of learning to analyze and innovate ideas (Association of American Colleges and Universities 2007).

Interestingly, a student's submitted photo can also give valuable insights into their understanding or misunderstanding of the concept they are trying to portray. One such example (Figure 5c) was a tree trunk with a large limb sawed off. The student stated that the image "signifies climate change because of the different ridges in

the bark." This provided an unexpected opportunity for faculty to clear up a misunderstanding.

The SENCER Student Assessment of Learning Gains (SALG, www.salgsite.org) allows students to rate how well specific activities help their learning. SALG data from five years (2007 to 2011) and more than 1300 instruments evaluating SENCER courses have indicated that this type of pedagogical approach enhances durable learning and a deeper understanding. Carroll (2012) reported that SENCER faculty are making more progress toward the main categories of pedagogical goals—those related to (a) understanding course content, (b) skill-building, (c) changing attitudes toward science, and (d) building habits of mind and behavior—than their non-SENCER colleagues. These surveys constitute about twenty-seven percent of the total SALG course evaluations in that period of time. Although we have not used SALG to evaluate the photo-book assignment, based on the reflective writing our students have done we expect that our students have acquired a deeper understanding and durable learning from this activity.

Conclusion

We developed the photo-book project as a creative learning activity in our courses to provide an opportunity for our students to develop a deeper understanding of the subject matter in our courses. We also wanted students to learn how relevant science subjects are to their everyday lives. After incorporating this project in various sections of three courses and one community outreach event, we believe the photo-book of concepts idea is a valuable tool for students and instructors alike. Our future plans include the use of the the photo-book assignment in courses we teach regularly and additional assessment through both our QEP program and the online SALG. Photo-books have great potential in terms of students' developing enduring learning, but they are also a manageable workload for faculty. The project has been successfully completed twice in physics classes, and once each in environmental chemistry and climate change. After additional experience, we may choose to make the photo-book assignment an embedded assessment tool.

This project can be employed in larger or small classes. The physics class had seventy-five students, while environmental chemistry had twenty-two and climate change had only ten. Varying the number of photos submitted (four in physics versus eight in environmental chemistry) made it easy to adjust the workload. The project does not require any specific device or equipment; students only need a camera, and most of our students have been using their cell phones. It is essential to have a practical way of dealing with large file sizes. We have accomplished this using submission via email to a special email account (e.g., physphotobook@gmail.com) or uploading into Blackboard, either into a Discussion Board (visible to all students) or as a graded assignment link that was not shared with other students. All processes worked well provided students were required to place each photo and the accompanying text on a presentation slide for submission. This is necessary in order to keep it practicable. Other tools such as cloud sharing of files are available as well. In any case, faculty need to be sure that their selection fits the technology limitations of their situation.

In this assignment we seek to help students understand the subject through connecting it to interests already in their daily life. For example, a student who attends a rodeo to watch a family member compete takes pictures of a rodeo event and connects the rodeo to physics. Such a student could be more interested in physics in the way William James (1899) stated, "Any object not interesting in itself may become interesting through becoming associated with an object in which an interest already exists."

Posters and oral presentations resulting from the photo-book activity have been shared during various meetings and symposia, both on and outside our campus. Faculty members in a wide variety of disciplines have shown an interest in this idea and have asked for our instructions, leading us to write this article in order to share our experiential model with a wider group of educators. We believe the photo-book of concepts will be a positive experience in whatever disciplines it may be applied.

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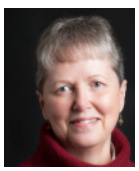
About the Authors

Nasrin Mirsaleh-Kohan received her Bachelor of Science degree in Physics at the University of Tehran. She came to the U.S. as a graduate student and earned her Master's degree in computational Physics at the Bowling Green State University. In 2008, she finished her Ph.D. in Physics from the University of Tennessee (UT), followed by a postdoctoral fellowship at the University of Sherbrooke in Canada. Then she returned to Tennessee and was a postdoctoral research associate at UT. Kohan accepted her first tenure-track faculty position at Texas Woman's University (TWU), Department of Chemistry and Biochemistry in May of 2013. She teaches algebra-based physics and calculus-based physics. Her research interests include surface-enhanced Raman scattering, interaction of anticancer drugs with DNA, negative ions, and radiation damage to DNA.

Nasrin is already a strong believer in using hands-on experiences to educate students. She is excited to have found a place that values her creative approach to teaching physics, as evidenced by her selection as a TWU Experiential Learning Fellow.

Kohan is co-advisor for the KEM Club (Kappa Epsilon Mu), TWU's student chapter of the American Chemical Society. She has incorporated various civic engagement activities in KEM club such as the Thanksgiving food drive and Calculate it Forward. Nasrin is also part of the SCI-Southwest team at TWU and helps to convey the mission of SENCER in the Southwest region.



Cynthia Maguire earned her B.S. from Central State University in Oklahoma and two M.S. degrees--biology teaching and chemistry teaching, both from Texas Woman's University. She remained at TWU and is now a Senior Lecturer in the Chemistry and Biochemistry department.

Ms. Maguire created the first SENCER course at TWU, Introduction to Environmental Chemistry: Global Perspectives, in the fall of 2007. She teaches primarily sustainability-related courses which form the core of an upper-division certificate program, Science Society and Sustainability. Cynthia is faculty advisor for Roots, a student sustainability organization at TWU; and she models civic engagement for her students through her leadership in the Native Plant Society of Texas, helping students be aware of sustainable, water- and habitat-conserving landscaping on their property and in their communities.

Maguire is also working on the SENCER dual poster project, researching how students learn to communicate disciplinary knowledge to others outside their specialty. Ms. Maguire is co-director of SCI-Southwest and is a SENCER Leadership Fellow. She was recently named a TWU Senior Experiential Learning Fellow. Her work has been published as a chapter in two ACS Symposium books about SENCER, and an article in The International Journal of Sustainability Education.

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Appendix

The following instructions for the photo-book concepts have been designed for the physics classes; however other instructors could modify the instructions as appropriate.

- In this project, students are required to take four to six photographs (depending on the size of the class) that represent the principles of the subject matter. For instance, in a physics class students could take a picture of a merry-go-round and present it as an example of the centripetal force application. Some of the instructions given to the students are as follows:
  - Pictures must be students' original pictures (pictures taken online or from other sources are NOT accepted).
  - Pictures should not include faces, especially children.
  - Students need to make sure they have permission when they take pictures of private properties.
  - Students need to email two of their pictures in a PowerPoint presentation to the instructor by a specific deadline to receive feedback on the pictures. In this PowerPoint, along with the pictures, they need to give each picture a title and write a caption describing the law or concepts of the subject matter the picture represents. It is also more convenient if the students title their PowerPoint presentation using their last name and first name (e.g., if John Smith is submitting the PowerPoint, the name of the file should be Smith_John). It is advised that the instructor (or TA) of the class create a separate email account since these files tend to be large and could fill up a personal inbox. The instructor can also ask students to use Blackboard or other tools (e.g., DropBox) to upload their pictures.
- All the pictures (could include the two pictures they have already submitted) should be sent to the instructor by a specific deadline along with their titles and descriptions.
- The instructor will then choose one picture from each student and will exhibit the pictures on the wall of the classroom (or anywhere that is convenient) on a specific day. You might remove the name of the students and just number them so that students would not know whose pictures they are discussing.
- After the exhibition, each student needs to choose one picture (not their own) that has attracted their attention and write a reflective paragraph on why the photo grabbed their attention and the relevance of the photo to a law/principle of the subject matter. The due date for this short paragraph could be a week after the exhibition.
- Finally, for a larger class the instructor will choose 15-20 representative pictures (the number is left to the discretion of the instructor) that show different areas and concepts in the course and print them on a poster. This poster could be displayed in the department and might even be presented in a larger scale on the campus or at conferences. For a smaller class, the instructor could divide students into groups and ask each group to make a poster presentation.

Physics photo-book assignment timeline		
	Due Date	Note
Submission of two photos	Week 7	Two photos along with titles and descriptions to receive feedback
Submission of final photos	Week 10	
Photo exhibition	Week 11	One picture chosen from each student exhibited on the wall of the physics laboratory
Reflective paragraph	Week 12	
Poster Presentation	Week 14	poster. (See Figure 1.)

Appendix

Environmental chemistry water poster assignment timeline		
	Due Date	Note
Submit eight photos	Week 5	
Preview in class	Week 6	Students selected their favorite images and organized them into topical groups in order to create posters
Water posters	Week 10	Each group created a poster
Poster presentation	Week 14	TWU Symposium

Physics photo-book rubric This assignment counted for 5% of the total grade in the class.		
Criteria	Weight	Note
Content	65%	Photos, titles, and descriptions are related to the class concepts.
Reflective paragraph	15%	Clearly describing the relevance of the photo (exhibited in the class) to a law/principle of the subject matter.
Format	10%	As described in the instruction.
On-time submission	10%	

Environmental chemistry water poster rubric The water poster counted for 5% of the total grade in the class.			
Criteria	Novice	Competent	Proficient
Content Weight 60%	25% Thoughts are poorly expressed. Photos may not relate well to theme of poster.	60% Ideas are clearly written. Photos relate to topic. There may not be a seamless connection between them.	100% Ideas and photos are focused on the topic and tell a story seamlessly. Clear communication of essential idea(s).
Format/organization Weight 20%	25% Poor use of space. Difficulty achieving an eye-appealing format.	60% Not all space is used well, but items are laid out reasonably well. Everything needed is present.	100% Space is used effectively. All parts of the poster are complete, and presentation is attractive to the eye.
Grammar/Typos Weight 20%	25% Several errors in spelling and/or punctuation. Difficult to understand what is intended.	60% One or two errors in spelling, but still communicates ideas clearly.	100% No errors in spelling or punctuation.